

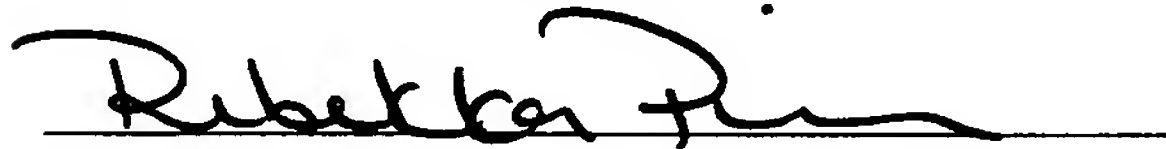
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CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of PCT/EP2004/053656, filed with the European Patent Office on December 22, 2004, and the new claims filed December 19, 2005.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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CIRCUIT CONFIGURATION FOR TRANSMISSION OF DATA SIGNALS  
FROM AND/OR TO HOUSEHOLD APPLIANCES

The invention relates to a circuit configuration for the transmission of data signals from and/or to household appliances between a first transceiver device and a second transceiver device via an AC power supply line system within a transmission frequency range which lies above the frequency of the AC power supply, wherein the respective transceiver is connected to a filter arrangement at the AC power supply line system.

In a known circuit configuration of the aforesaid type (D1: US 6,396,392 B1) the respective transceiver comprises a modem connected to the respective household appliance which is connected to the AC power supply line system via a coupler. Various filters such as low-pass filters are contained both in the modem and in the coupler and the respective coupler is impedance-matched to the impedance of the AC power supply line system both on the input side and on the output side (see in particular Fig. 2 and Fig. 11 of US 6,396,392 B1). In this connection, nothing is known about using filter arrangements in the AC power supply input circuit of the respective household appliance.

In a further known circuit configuration for the transmission of data signals from and/or to household appliances (D2: US 6,590,493 B1), in each case a group of individual household appliances is connected to an AC power supply line system via a separate filter arrangement. The filter arrangements of different groups of household appliances are dimensioned so that the data signals transmitted in one group of household appliances cannot reach the household appliances belonging to another group of household appliances. LC low-pass filters of

1 different configurations are used for the relevant filter  
2 arrangements. In this connection, nothing is known about  
3 problems with matching the impedances of these filter  
4 arrangements to the impedance of the AC power supply line  
5 system.

6  
7 To avoid HF interference signals being emitted from a  
8 household appliance connected to a AC power supply line  
9 system, it is generally known (D3: Siemens Switching  
10 Examples, 1974/75 edition, page 128, Fig. 6.4 and page 129,  
11 Fig. 6.5) to connect a capacitor arrangement between the  
12 voltage-carrying power supply line and a neutral conductor,  
13 this capacitor arrangement comprising a series circuit of two  
14 capacitors (known as Y capacitors) of relatively low  
15 capacitance whose common connection point is connected to an  
16 ground connection of the relevant power supply of the  
17 relevant household appliance. Optionally, a higher-  
18 capacitance single capacitor (known as an X capacitor) is  
19 connected in parallel to this capacitor series circuit.  
20 Matching of the impedance of the AC power supply input  
21 circuit of the relevant household appliance to the impedance  
22 of the power supply line supplying the AC voltage is not  
23 provided here.

24  
25 [005] In addition to the interference suppression measure  
26 last considered it is further known (D4: Siemens Switching  
27 Examples, 1977/78 edition, page 137, Fig. 6.4 and page 152,  
28 Fig. 6.8) to provide a current-compensated choke arrangement  
29 in the AC power supply input circuit, comprising two choke  
30 windings of which one is located in the current-carrying  
31 power line and the other lies in the relevant neutral  
32 conductor. This type of current-compensated choke arrangement  
33 prevents common-mode interference pulses originating from the  
34 relevant appliance from entering into the power supply. In

1 this case also, nothing is known about any matching the  
2 impedance of the filter arrangement used in the AC power  
3 supply input circuit of the relevant household appliance to  
4 the impedance of the AC power supply line system.

5  
6 [006] In a circuit configuration of the type specified  
7 initially, it has now been established that a filter  
8 arrangement used hitherto in conjunction with the respective  
9 transceiver device similar to the filter arrangement known  
10 from D1 with the usual dimensions can substantially reduce  
11 the respectively emitted transmission level at the AC power  
12 supply line system so that these signals can only be received  
13 without interference over a relatively short distance by a  
14 receiver device connected to the AC power supply line system.

15  
16 [007] It is thus the object of the invention to show a way of  
17 constructing a circuit configuration of the type specified  
18 initially with a relative low filter expenditure whilst  
19 avoiding the disadvantage indicated hereinbefore.

20  
21 [008] The object indicated hereinbefore is achieved in a  
22 circuit configuration of the type specified initially by the  
23 respective filter arrangement containing a power supply low-  
24 pass filter which is arranged in the input circuit of the  
25 power supply unit of the associated transceiver device and is  
26 provided with an impedance curve such that the impedance  
27 thereof in said transmission frequency range has a value that  
28 is at least twice as high as the impedance of the AC power  
29 supply line system in said transmission frequency range.

30  
31 [009] The invention has the advantage that as a result of  
32 said dimensioning of the power supply low-pass filter which  
33 is arranged in the input circuit of the power supply unit of  
34 the associated transceiver device, the transmission level

1 delivered by the relevant transceiver device to the AC power  
2 supply line system is not reduced so substantially as is the  
3 case when using the filter arrangement used so far. The  
4 dimensioning of the afore-mentioned power supply low-pass  
5 filter according to the invention will be discussed in  
6 further detail below. At this point, it may be noted that a  
7 transceiver device is understood to be a transmitting and/or  
8 receiving device according to the case.

9  
10 [010] Appropriately in an AC power supply line system  
11 comprising at least one current-carrying line conductor and  
12 an ground conductor, the power supply low-pass filter  
13 consists of an inductive component located in the respective  
14 line conductor and a capacitor arrangement located between at  
15 least one end of the relevant inductive component and the  
16 ground conductor. This yields the advantage of a power supply  
17 low pass filter which is particularly easy to implement.

18  
19 [011] The afore-mentioned capacitor arrangement preferably  
20 consists of a single capacitor (X capacitor) which connects  
21 the end of the inductive component on the power supply unit  
22 side to the ground conductor of the AC power supply line  
23 system and a series circuit of two capacitors (Y capacitors)  
24 connected in parallel to this single capacitor, whose common  
25 connection point is connected to the ground connection of the  
26 relevant power supply unit. A capacitor arrangement having  
27 this structure thus particularly effectively prevents HF  
28 interference signals produced in the relevant household  
29 appliance or the relevant transceiver device from entering  
30 into the AC power supply line system.

31  
32 [012] An ohmic resistor is appropriately connected in  
33 parallel to said capacitor arrangement. This ohmic resistor  
34 advantageously serves to unload the capacitor arrangement

1 after disconnecting the entire circuit configuration from the  
2 AC power supply line system so that in this state no problems  
3 arise through contact of otherwise current-carrying lines or  
4 part of the relevant circuit configuration.

5  
6 [013] In order to avoid common-mode interference signals from  
7 the respective household appliance or the respective  
8 transceiver device being delivered to the AC power supply  
9 line system, preferably respectively one winding of a  
10 current-compensated choke is inserted in the conductor  
11 sections of the power supply low pass filter connected to the  
12 respective line conductor and the ground conductor of the AC  
13 power supply line system.

14  
15 [014] The invention is explained in detail hereinafter using  
16 an exemplary embodiment with reference to the drawings.

17  
18 [015] Fig. 1 shows a schematic diagram of a circuit  
19 configuration according to one embodiment of the present  
20 invention.

21  
22 [016] Fig. 2 illustrates in an equivalent circuit diagram the  
23 impedance relationships on the transmission side and on the  
24 receiving side in circuit configurations of the type shown in  
25 Fig. 1.

26  
27 [017] Fig. 3 shows the structure of a power supply low pass  
28 filter as used in a circuit configuration according to Fig.1.

29  
30 [018] Figure 1 shows an embodiment of a circuit configuration  
31 according to the present invention belonging to a household  
32 appliance HG. The household appliance concerned can be any  
33 networkable household appliance such as a washing machine, a  
34 drier, a cooker, a refrigerator, a heating system etc. A



1 networkable household appliance is to be understood here as a  
2 household appliance which can be connected to a communication  
3 network for the transmission of various data signals by means  
4 of a transmitting and/or receiving device. In the present  
5 case, this communication network comprises the AC power  
6 supply from which the supply voltages required for operation  
7 of the respective household appliance are taken.

8  
9 [019] The circuit configuration according to Fig. 1 comprises  
10 a transceiver device in the form of a modem whose  
11 transmission output and whose receiving input are connected  
12 to an AC power supply line system PL of the aforesaid AC  
13 power supply. In the present case, the AC power supply line  
14 system merely comprises a current-carrying conductor line NL  
15 and an ground conductor NO; the relevant AC power supply line  
16 system is thus a single-phase AC power supply line system.  
17 However, a multiphase AC power supply line system can also be  
18 used.

19  
20 [020] Furthermore, a power supply filter FI is connected to  
21 the two lines NL and NO of the AC power supply line system NL  
22 on the input side. In the present case, this power supply  
23 filter FI is a power supply low pass filter which attenuates  
24 the AC power supply at the AC power supply frequency of 50 Hz  
25 or 60 Hz very little if at all. The impedance of the  
26 associated low-pass power supply filter FI at the AC power  
27 supply frequency is of the order of magnitude of a few  
28 milliohms. On the other hand, the impedance of the relevant  
29 low-pass power supply filter FI in the transmission frequency  
30 range in which data signals are transmitted from the modem MO  
31 and/or to said modem is substantially higher, being in the  
32 range of a few ohms. This will be discussed in further detail  
33 below.

1 [021] The power supply filter FI considered previously is  
2 connected before the input of a power supply unit PS which  
3 provides the various supply voltages required by the  
4 individual devices or appliance parts of the household  
5 appliance HG under consideration. In the present case, merely  
6 a control device CT is shown as representative of all the  
7 devices of the household appliance HG provided which have  
8 their supply voltages supplied from the power supply unit PS.  
9 The control device CT is connected to the modem MO via  
10 control lines for bidirectional signal transmission. This  
11 means that the modem MO receives control signals supplied by  
12 the control device CT and that conversely signals for  
13 processing are fed to the control device CT from the modem  
14 MO. These signals are usually obtained from the transmission  
15 of data signals which are delivered from the modem MO via the  
16 AC power supply line system PL and/or which are supplied to  
17 the modem MO via this AC power supply line system PL.

18  
19 [022] The modem MO operates here as an AC power supply or  
20 powerline communication device, for example, in a working or  
21 transmission frequency range of 95 kHz to 148.5 kHz. This  
22 transmission frequency range is thus significantly higher  
23 than the power supply frequency (50 Hz or 60 Hz) of the AC  
24 power supply.

25  
26 [023] The relevant household appliance HG or more accurately  
27 its relevant transceiver, that is the modem MO, is in  
28 communicating connection with at least one second transceiver  
29 for transmission of data signals via the AC power supply line  
30 system PL. The relevant second transceiver can belong to a  
31 further household appliance or for example, to a common  
32 control and monitoring device provided for a plurality of  
33 household appliances. Data signals can be transmitted between  
34 this control and monitoring device and the individual



1 transceivers of the respective household appliances via the  
2 AC power supply line system, for example in the course of  
3 updating control programs for the individual household  
4 appliances and/or for carrying out remote diagnoses in the  
5 relevant household appliances.

6  
7 [024] The equivalent circuit diagram shown in Fig. 2 will be  
8 discussed to explain the measures according to the invention  
9 taken in connection with the transmission of data signals in  
10 the circuit configuration shown in Fig. 1. In the left half  
11 this equivalent circuit diagram shows the impedance  
12 relationships which are relevant to the transmission side of  
13 a first transceiver device, that is for the case where in the  
14 circuit configuration shown in Fig. 1, data signals are  
15 transmitted by the modem MO via the AC power supply line  
16 system PL. These data signals may be generated by a generator  
17 G shown schematically in Fig. 2 which may have an impedance  
18  $Z_s$  of about 1 Ohm at a transmission frequency of, for  
19 example, 132.5 kHz.

20  
21 [025] The power supply line impedance  $Z_n$  effective between  
22 the power supply conductor NL and the ground conductor NO of  
23 the AC power supply line system PL forms, together with the  
24 transmission-side impedance  $Z_s$ , a voltage divider through  
25 which only a fraction of the amplitude of the data signals  
26 delivered by the generator G is decreased at the power supply  
27 impedance  $Z_n$ . At a usual or typical power supply impedance  $Z_n$   
28 of about 3 Ohm at the aforementioned transmission frequency  
29 of, for example, 132.5 kHz, the original transmission  
30 amplitude is therefore only decreased by 75% at this power  
31 supply impedance.

32  
33 [026] In order that this amplitude should not be lowered  
34 considerably further, it is provided according to the

1 invention that the low pass power supply filter FI whose  
2 impedance  $Z_{fi}$  is in parallel with the power supply impedance  
3  $Z_n$ , in the transmission frequency range of the modem MO, that  
4 is in the present case at a frequency of 132.5 kHz, should be  
5 given an impedance which is at least twice as high as the  
6 impedance  $Z_n$  in the relevant transmission frequency range. If  
7 for the numerical values given previously, the impedance  $Z_{fi}$   
8 at the frequency of 132.5 kHz is specified, for example, as 6  
9 Ohm, the total impedance of  $Z_n$  and  $Z_{fi}$  is now 2 Ohm. This  
10 means that now only two-thirds, that is about 67.1% of the  
11 voltage amplitude of the data signal amplitude delivered by  
12 the generator G is available on the AC power supply line  
13 system PL.

14  
15 [027] If an impedance  $Z_{fi}$  of 12 Ohm, that is four times the  
16 power supply impedance  $Z_n$ , were to be given to the low pass  
17 power supply filter FI at the aforementioned frequency of  
18 132.5 kHz, for example, this would give a total impedance  
19 between the power supply line NL and the ground conductor NO  
20 of the AC power supply line system PL of 2.4 Ohm. As a  
21 result, about 70% of the amplitude of the data signal  
22 amplitude delivered by the generator G would be available on  
23 the AC power supply line system, that is, more than in the  
24 case considered previously. As a result of this measure, the  
25 range for the transmission of data signals is increased  
26 significantly compared with the case where very low-  
27 resistance power supply filters FI are used, that is power  
28 supply filters which, at the afore-mentioned frequency of  
29 132.5 kHz for example, have an impedance of the order of  
30 magnitude of the impedance of the AC power supply line system  
31 or even an impedance below this impedance.

32  
33 [028] At this point, it may be noted that the previously  
34 indicated effect of weaker attenuation of the AC power supply

1 line system could be achieved in principle by an even higher-  
2 resistance low pass filter at the transmission frequency  
3 under consideration. However, this would necessitate an  
4 increased expenditure on circuitry which is undesirable. In  
5 any case, the measure according to the invention yields a  
6 power-supply low-pass filter optimised with regard to  
7 impedance relationships with relatively low expenditure on  
8 circuitry.

9  
10 [029] The right half of the equivalent circuit diagram  
11 according to Fig. 2 shows the impedance relationships which  
12 are relevant to the receiving side of a circuit configuration  
13 of the type shown in Fig. 1. As can be seen, a transmission  
14 line impedance  $Z_{\text{ü}}$  of the AC power supply line system leading  
15 to the relevant receiving side initially has an effect on the  
16 receiving side. This impedance  $Z_{\text{ü}}$  can be, for example, 3 Ohm.

17  
18 [030] The incoming data signals via the impedance  $Z_{\text{ü}}$  on the  
19 receiving side of a second transceiver device are effective  
20 at the impedance  $Z_{\text{n}}$  of the AC power supply line system on the  
21 receiving side. This impedance  $Z_{\text{n}}$ , which can be 3 Ohm for  
22 example as specified above, firstly lies parallel to the  
23 impedance  $Z_{\text{fi}}$  of the power supply low-pass filter provided on  
24 the receiving side and also the input impedance  $Z_{\text{e}}$  of the  
25 circuit configuration provided on the receiving side lies  
26 parallel to the parallel circuit comprising the impedances  $Z_{\text{n}}$   
27 and  $Z_{\text{fi}}$ . As a result of this parallel circuit, an overall  
28 relatively low input receiving level is obtained on the  
29 receiving side. In order not to allow this input receiving  
30 level to drop so sharply, the impedance  $Z_{\text{fi}}$  of the power  
31 supply low pass filter provided on the receiving side is set  
32 in the transmission frequency range of the entire arrangement  
33 so that it has a value at least twice as high as the  
34 impedance  $Z_{\text{n}}$  of the AC power supply line system in the

1   aforementioned frequency range. The input impedance  $Z_e$  on the  
2   receiving side should also be selected to be relatively high.

3  
4   [031] Figure 3 shows the basic structure of a power supply  
5   low pass filter FI used in the circuit configuration  
6   according to the invention according to one embodiment.  
7   Between an input connection EN and an output connection AN,  
8   as important components for the low pass filter  
9   characteristic, the relevant power supply low pass filter FI  
10   contains an inductive component L, such as a choke coil, and  
11   a capacitor arrangement C1, C2, C3 located between one end of  
12   the relevant inductive component L and connecting line  
13   provided between an input connection E0 and an output  
14   connection A0. In the circuit configuration according to Fig.  
15   1, the aforementioned input connection EN is connected to the  
16   line conductor NL and aforementioned input connection E0 is  
17   connected to the ground conductor N0. The power supply unit  
18   PS shown in Fig. 1 is connected to the output connections AN  
19   and A0 according to Fig. 3 on the input side.

20   [032] The aforementioned capacitor arrangement consists of a  
21   single capacitor C1, also designated as an X capacitor, which  
22   connects the inductive component L at the power supply unit  
23   end to the ground conductor of the AC power supply line  
24   system and a series circuit of two capacitors, also  
25   designated as Y capacitors, connected in parallel to the  
26   single capacitor C1. The common connection point of the two  
27   aforementioned capacitors C2 and C3 is connected to the  
28   ground connection of the relevant power supply unit PS.

29  
30   [033] Connected in parallel to the capacitor arrangement  
31   considered previously, consisting of the capacitors C1, C2  
32   and C3, as shown in Fig. 3 is an ohmic resistance R which can  
33   have a relatively high resistance and which, for example, can  
34   have a value of 500 kOhm. As mentioned previously, this ohmic

1 resistance R is used to unload the capacitor arrangement if  
2 the power supply filter FI is not fed by a power supply.

3  
4 [034] In addition to the components considered previously,  
5 the power supply low pass filter shown in Fig. 3 has a  
6 current-compensated choke DR with two windings W1, W2. One  
7 winding W1 lies in the line branch between the input  
8 connection EN and the output connection AN and the other  
9 winding W2 lies in the line branch between the input  
10 connection E0 and the output connection A0. This current-  
11 compensated choke is merely used to suppress common-mode  
12 interference signals which could originate from the power  
13 supply unit PS and which must not enter into the AC power  
14 supply line system. Both the relevant current-compensated  
15 choke DR and the high-resistance resistor R have no influence  
16 on the low-pass characteristic of the power supply low pass  
17 filter. The characteristic of the relevant power supply low  
18 pass filter is merely determined by the inductor component L  
19 and the capacitors C1, C2 and C3. The relevant capacitor  
20 arrangement can optionally be reduced to a single capacitor,  
21 such as the capacitor C1.

22  
23 [035] Reference list

24 [036] Table 1

25	A0	Output connection
26	AN	Output connection
27	C1	Capacitor
28	C1, C2, C3	Capacitor arrangement
29	C2	Capacitor
30	C3	Capacitor
31	CT	Control device
32	DR	Current-compensated choke
33	E0	Input connection
34	EN	Input connection

1	FI	Power supply filter, power supply low pass
2	filter	
3	G	Generator
4	HG	Household appliance
5	L	Inductive component, choke coil
6	MO	Transceiver, modem
7	NO	Ground conductor
8	NL	Line conductor
9	PL	AC power supply line system
10	PS	Power supply unit
11	R	Ohmic resistor
12	W1	Winding
13	W2	Winding
14	Ze	Input impedance
15	Zfi	Impedance
16	Zn	Power supply line impedance
17	Zs	Impedance
18	Zü	Transmission line impedance
19		